Nov 7th, 9:00 AM - 5:00 PM

Effect of Steel Fiber and Polypropylene Fiber on Reinforced Concrete

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Abstract. This paper presents the results of an experimental study that investigated, the effects of steel fibers and polypropylene fibers on the mechanical properties of concrete.
Two types of fibers used are hooked end steel fibers of 50 mm and 30 mm length with the aspect ratio of 67 (length 50 mm and diameter 0.75 mm) and 44 (length 30 mm and diameter 0.75 mm). On the other hand, three types of polypropylene fibers are used of length 12mm, 6mm and 3 mm. Steel fibers are used of 0%, 0.25%, 0.5%, and 1% by the volume of concrete and polypropylene fiber are prepared of 0 %, 0.25 %, 0.5 %, 1 % by the weight of cement.
The experimental program consisted of testing the compressive strength and split tensile strength on steel fiber- reinforced concrete and polypropylene fiber-reinforced concrete.
28 day compressive and split tensile strength ëere prepared and tested by using cubes of dimensions 10 cm X10 cm X10cm.

Keywords: Aspect Ratio, Steel Fiber, Polypropylene Fiber, Polypropylene Fiber-Reinforced

1. Introduction

Fiber reinforced concrete (FRC) is a composite material consisting of cement, sand, coarse aggregate, water and fibers. In this composite material, short discrete fibers are randomly distrubuted throughout the concrete mass. The behavioral efficiency of this composite material is far superior to that of plain concrete and many ohter construction materails of equal cost. [1], [12]
Due to this benifit, the use of FRC (Fiber Reinforced Concrete) has steadily increased during the last two decades and its current field of application includes : airport and
highway pavement, earthquake resistant and explosive resistant structures mine and tunnel linings, bredge deck etc.[2]
Review of work done by various researcher discuss the mechanism of fiber matrix interaction where various models are used to compute the bonding between the fibers and cement matrix.as the bonding of fiber and the matrix plays a major role in the composite behavior.[3],[13]
The randomly distributed short fibers are generally introduced into concrete to enhance its control crack system and mechanical properties such as toughness, impact resistance, ductility. Properties of fibers based concrete changes with varying concrete fiber materials geometry distribution, orientation and densities. [4]
When fibers is added to a concrete mix each and every individual fiber receives a coating of cement paste. This increasing bonding with cement matrices and minimized chemical reaction between fibers and cement matrices. [5]
The evaporation of concrete surfaces water is factor in creating the contract paste fracture in concrete which leads with to the formation of stress since the concrete starts to strengthness. [6]
The split tensile strength of all fibrous composite matrices was significantly higher than that of plain concrete. This is because in fibrous matrix when it cracks cause the load to be transferred from the cementitious at the crack interface.[7]

2. Materials and mix proportions

2.1 Materials

The cement used in concrete mixtures was ordinary Portland cement of 32.5 grade. Fine aggregate and coarse aggregate of river of Milot with maximum size of 25 mm are used. Natural river sand from Milot river is used with maximum size of 5mm. Two types of fibers were used for present investigation as shown in figure 2 hooked steel fibers - 50mm and 30 mm long and figure 1 polypropylene fibers with 12mm , 6mm and 3mm length.

Fig 1. Polypropylene Fiber 12 mm , 6mm and 3 mm

Fig 2. Steel Fiber 3 cm and 5 cm

2.2 Mix Design

Mix design was done as per ASTM C 1116-91. The super plasticizer dosage was adopted as 0.25 % by the weight of cement [9]

Table 1: Mix design of concrete

Mix proportion	**Specifc gravity (kg/m^3)**	**Ratio**
Sand	900	
Cement	400	Water: Cement 0.5
Coarse Aggregate 10-25 mm	670	
Coarse Aggregate 5-10 mm	300	Aggregate: Cement 2.67
Water	200	
Super plasticizer	1	Superplasticizer 0.25 % by the weight of cement
Steel Fiber SF1= 5 cm SF2= 3 cm		0.25 % , 0.5 % ,1 % by the volume of concrete
Polypropylene Fiber PP1= 12 mm PP2= 6 mm PP3= 3mm		0.25 % , 0.5 % 1 % by the weight of cement

2.3 Preparations and curing of test samples

The preparation of all test samples was prepared in a 50 l concrete mixer. The mixing procedure was used is : dry mixing of aggregate in mixer 0.5 min , dry mixing of cement and aggregate in mixer 0.5 min addition of water, mixing for 3 min , addition of superplasticizer and then fiber, mixing by mixer for 2.5 up to 3.5 min [8], [10], [11].

Compressive Strength

Compression test were carried out at the age of 28 day, on cubic specimens (100x100x100 mm) Test were done using a hydraulic press. The specimens were centered on the tray of the press then a continuous load was applied on the specimen.

The ultimate compression load for each plain concrete and fiber reinforced concrete specimen were recorded.

Split Tensile strength

Flexural Strength test at the age of 28 days were performed on plain and fiber reinforced concrete cubic specimens (100x100x100 mm)...

3. Result and conclusion

Below are represented the result of compressive and split tensile strength of steel and polypropylene reinforced concrete

Table 2 : Results of Compressive Strength of Steel Reinforced Concrete

Type of fibers	Compressive Strength N/mm^2 0% Steel Fiber	Compressive Strength N/mm^2 0.25 % steel fiber	Compressive Strength N/mm^2 0.5 % Steel fiber	Compressive Strength N/mm^2 1 % Steel Fiber
SF1 Steel Fiber 5 cm	29.52	30.4	32.7	33.5
SF2 Steel Fiber 3 cm	29.5	29.52	33.5	34.7

Table 3 : Result of tensile Strength of Steel Reinforced Concrete

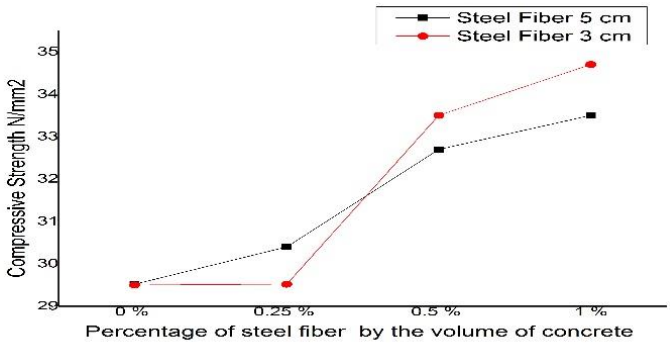
Type of fibers	Split Tensile Strength N/mm^2 0% Steel Fiber	SplitTensile Strength N/mm^2 0.25%SteelFiber	Compressive Strength N/mm^2 0.5% Steel Fiber	Compressive Strength N/mm^2 1 % Steel Fiber
SF1 Steel Fiber 5 cm	3.02	3.1	3.53	3.53
SF2 Steel Fiber 3 cm	3	3.57	3.7	3.9

Table 4: Results of Compressive Strength of Polypropylene Reinforced Concrete

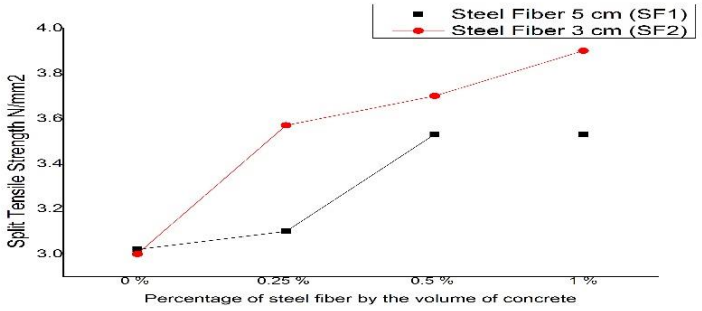
Type of PP fiber	Compressive Strength N/mm^2 0% polypropylene fiber	Compressive Strength N/mm^2 0.25% polypropylene fiber	Compressive Strength N/mm^2 0.5% polypropylene fiber	Compressive Strength N/mm^2 1% polypropylene fiber
Polypropylene 12 mm (PP1)	29.52	32.4	37.6	38.78
Polypropylene 6 mm (PP2)	29.5	27.76	35.6	31.81
Polypropylene 3mm (PP3)	29.52	18.25	34.9	29.8

Table 5: Results of Split Tensile Strength of polypropylene reinforced concrete

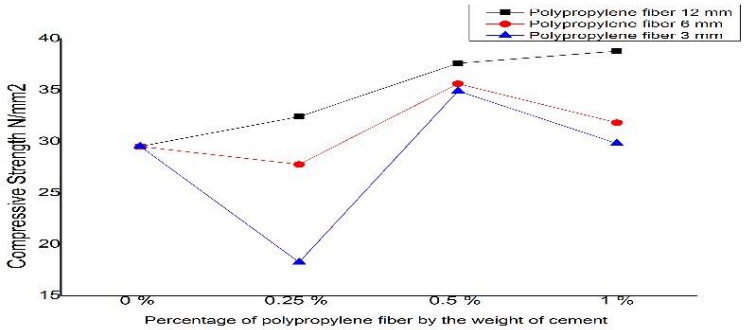
Type of PP fiber	Split Tensile N/mm^2 0% Polypropylene fiber	Split Tensile N/mm^2 0.25% Polypropylene fiber	Split Tensile N/mm^2 0.5% polypropylene fiber	Split Tensile N/mm^2 1% polypropylene fiber
Polypropylene 12 mm (PP1)	3.02	3.27	3.9	4.18
Polypropylene 6 mm (PP2)	3.02	3.21	3.8	4.19
Polypropylene 3mm (PP3)	2.99	2.8	3.29	3.6



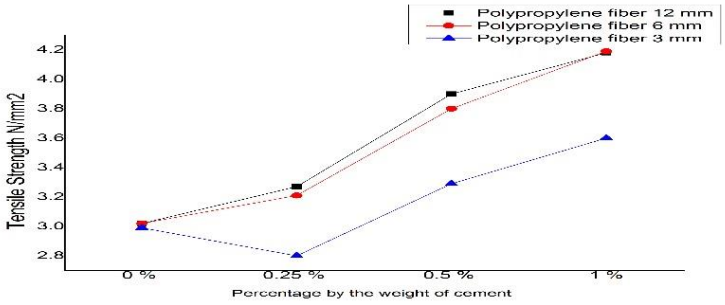
Graph 1: Comparison of compressive strength of steel reinforced concrete at room temperature



Graph 2 : Comparison of split tensile strength of steel reinforced concrete at room temperature



Graph 3 : Comparison of compressive strength of polypropylene reinforced concrete at room temperature



Graph 4: Comparison of split tensile strength of polypropylene reinforced concrete at room temperature

Conclusion

1. Among 37 different matrices considered in the present investigation , matrix having 1 % volume fraction of steel fibers 3 cm and 1% volume by cement of PP fibers 12 mm indicated the maximum increases in compressive strength .
2. Whereas matrix having 1% of steel fibers 3 cm and 1% polypropylene 12 mm had the best performance in split tensile strength .Also ratio 0.5 % polypropylene 6mm had shown good results.

3.Thus the optimum fiber ratio of 1 % by the volume of concrete of steel fiber with 3 cm length and polypropylene 1% by the weight of cement of length 12 mm have shown the best performance and offer potential advantages in improving concrete properties.

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